INNOVATIVE TECHNOLOGY
Summary Report

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Stereo Viewing System

Tanks Focus Area

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INNOVATIVE TECHNOLOGY
Summary Report

Stereo Viewing System

OST/TMS ID 890

Tanks Focus Area

Demonstrated at
Hanford Site
Richland, Washington

INNOVATIVE TECHNOLOGY
Summary Report

Purpose of this document

Innovative Technology Summary Reports are designed to provide potential users with the information they need to quickly determine whether a technology would apply to a particular environmental management problem. They are also designed for readers who may recommend that a technology be considered by prospective users.

Each report describes a technology, system, or process that has been developed and tested with funding from DOE's Office of Science and Technology (OST). A report presents the full range of problems that a technology, system, or process will address and its advantages to the DOE cleanup in terms of system performance, cost, and cleanup effectiveness. Most reports include comparisons to baseline technologies as well as other competing technologies. Information about commercial availability and technology readiness for implementation is also included. Innovative Technology Summary Reports are intended to provide summary information. References for more detailed information are provided in an appendix.

Efforts have been made to provide key data describing the performance, cost, and regulatory acceptance of the technology. If this information was not available at the time of publication, the omission is noted.

All published Innovative Technology Summary Reports are available on the OST Web site at http://ost.em.doe.gov under "Publications."

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SECTION 1
SUMMARY

Technology Summary

At the Idaho National Engineering and Environmental Laboratory (INEEL), 11 high-level liquid waste tanks at Idaho Nuclear Technology and Engineering Center (INTEC) require internal inspection, residual waste sampling, and inventory characterization prior to closure. The tanks are single-shell, stainless steel tanks contained in concrete vaults. The concrete vaults do not meet the necessary requirements for secondary containment and therefore all of the tanks must be removed from service by the end of 2012. Assessment of tank integrity is part of the INTEC program for corrosion control. Tanks integrity inspections are required to certify an emergency spare tank in accordance with the Notice of Noncompliance Consent Order (NON/CO). In addition, the tank integrity will be factored into the risk models used for closure of the INEEL Tank Farm.

How it Works

Figure 1 shows the Stereo Viewing System (also known as the high-resolution stereo video system end effector) designed to provide close up inspection of internal tank structures. Stereoscopic viewing enables operators to evaluate the depth of pits, seams, and other anomalies in the tank. It is one of various tools, deployed by the Light Duty Utility Arm (LDUA) called "end effectors." It is specifically designed for remote operation in underground hazardous waste storage tanks.

Figure 1. The Stereo Viewing System end effector uses video cameras that enable close up inspection of tank structures.

The Stereo Viewing System uses a pair of video cameras and several sets of lenses with different focal lengths in conjunction with special image processing technology to enable the perception of depth. The hardware is modified from available technology to perform in radioactive environments. Camera signals are processed by the Stereo Viewing System and displayed on a high-refresh-rate computer monitor. Special liquid crystal display shutter glasses are synchronized with the processed image on the monitor, creating the perception of depth.

Advantages Over Baseline

The baseline is tank inspection performed by lowering a film or video camera to positions directly below the riser and obtaining data from a single location, possibly at multiple elevations. The camera is manually deployed by operators through the riser exposing operators to radiation. The baseline technology cannot position the camera at multiple locations away from the tank riser and does not provide stereoscopic viewing capability.

There are several advantages to using the Stereo Viewing System over baseline techniques:

- Remote operation reduces risk from exposure to workers.
- It allows operators to perform close up inspections.
- This technology could be adapted for other deployment platforms.

The following potential disadvantages affect the selection of the Stereo Viewing System for use in tank waste operations:

- Specially trained personnel are required to operate the LDUA and the Stereo Viewing System.
- A large amount of support equipment is necessary to perform operations, mostly associated with the requisite LDUA system, but also for the end effectors.

Potential Markets

This technology has the potential for use at other DOE sites for in-tank activities. The Stereo Viewing System may be used as is or with enhancements in tanks different in size and type from the tank it was deployed in at INTEC.

Demonstration Summary

The Stereo Video System was demonstrated at Hanford in May 1995 and in October 1996. This technology was deployed with the LDUA at INEEL's INTEC on February 12, 1999.

Key Results

At Hanford, stereo viewing enabled operators to remotely evaluate the depth of pits, seams, and other anomalies. During the INTEC deployment, the tanks were visually inspected with a modified Stereo Viewing System that allowed the operators to observe the tank conditions prior to actual tank inspection and sampling.

Participants

The following parties contributed to successful demonstrations and deployment:

- Tanks Focus Area (TFA)
- DOE Office of Science and Technology (OST)
- DOE Office of Environmental Restoration (ER)
- Pacific Northwest National Laboratory (PNNL)
- Idaho National Engineering and Environmental Laboratory
- Lockheed Martin Idaho Technologies Company
- Lockheed Martin Energy Systems
- Westinghouse Hanford Company
- Savannah River Technology Center
- Bristlecone Environmental Technologies

Commercial Availability

Technologies comprising the Stereo Viewing System are commercially available. The end effector patent is pending.

Future Plans

The LDUA will be used in FY00 to inspect and take heel samples from INTEC Tanks WM-182 and WM-183 to support planning for closure activities, which are scheduled to begin in FY03. Use of the LDUA and various end effectors will continue through FY2012 to support inspection and heel characterization of the remaining tanks and beyond FY2012 to support the tank closure campaigns.

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Other

All published Innovative Technology Summary Reports are available on the OST Web site at http://ost.em.doe.gov under “Publications.” The Technology Management System (TMS), also available through the OST Web site, provides information about OST programs, technologies, and problems. The OST/TMS ID for the Stereo Viewing System is 890.

SECTION 2
TECHNOLOGY DESCRIPTION

Overall Process Definition

The LDUA is typically deployed with a specialized end effector tool that performs a specific task. Specialized end effector tools can perform tasks on tanks and tank waste, such as inspection, characterization, monitoring, retrieval, and pretreatment. For further detail on the LDUA (OST/TMS ID 85), see the Innovative Technology Summary Report (DOE/EM-0406).

Goals and Objectives
The LDUA enables deployment and operation of the Stereo Viewing System, which is used to conduct visual inspections inside tanks prior to deployment of other end effectors.

Description of Technology
The Stereo Viewing System is remotely deployed inside tanks using the LDUA. The components of the Stereo Viewing System includes: pair of color video cameras, lens system with zoom capability, lighting system, image processing system, liquid crystal display shutter glasses, and stereoscopic display monitor. All viewing functions are remotely operated. Positioning all control components in a remote facility prevents potential personnel exposure to radiation and contamination.

Basic Principle of the Technology
The video signals are processed and displayed on the high-refresh-rate computer monitor. Special liquid crystal display shutter glasses are synchronized with the processed image on the monitor, creating the perception of depth. Inspection data can be recorded on both the computer's hard drive and videotape. Importantly, the inspection data are linked with manipulator position data. Manipulator position data are integrated into both the electromagnetic and a video data stream, which enables later return to defects and other points of interest during the same deployment campaign.

Deployment of the Stereo Viewing System may be coupled with other types of remote viewing equipment. An Overview Video System provides a view of the interior of the tank and it can be used prior to deployment of the LDUA. It is primarily intended for initial entry viewing to avoid collisions. The Portable Overview Video System is a multipart version of the Overview Video System that can be hand-carried to the tank entry riser.

Specific DOE Applications
The interior of underground storage tanks must be assessed as part of the ongoing management of the tanks integrity and as a step towards tank remediation. Viewing and documenting the tank interiors and their associated annular spaces is an extremely valuable tool in characterizing tank condition and contents and in planning their remediation. The Stereo Viewing System can also be deployed in flammable environments in conjunction with protective provisions in the LDUA.

System Operation

Operation of the Stereo Viewing System is performed remotely from the control trailer outside the tank radiation area to reduce worker exposure. The end effector is positioned by the LDUA to the desired inspection location. The end effector controls are operated from the LDUA control trailer.

Operational Parameters and Conditions
The system provides high-resolution video images to a remotely located operator. The unit is self-purging, modular in construction, and completely self-contained for video, zoom lens, and lighting deployment. The system is designed to withstand temperatures 0–50^{o}C. Because the Stereo Viewing System is deployed inside an underground tank, severe weather is not a major concern for the end effector. It is a concern or constraint for operation of the LDUA, especially during heavy rain, excessive snow accumulation, extreme cold, or high winds. An enclosed tent or rigid tank riser interface housing encloses the riser area where end effectors are exchanged. If winds are high, the LDUA mast can be

lowered from the vertical position to prevent damage to the system. Decontamination water generated during extraction of the LDUA is left in the tank.

Materials and Labor

Two operators are needed to operate the LDUA system from within the operations control trailer. One operator controls the LDUA, and the other controls the installed end effector and the video displays and recorders. Two additional operators are needed to perform end effector exchanges and to decontaminate the LDUA and end effectors during removal from the tank.

Technical Skills/Training

Because the Stereo Viewing System and the LDUA system are unique, special training has been required to ensure safe operation. The system operators develop, verify, and practice operating procedures in the cold-test facilities, as shown in Figure 2. The training for Hanford was done at the FEMF building. The training at INTEC took place in the Fuel Processing Restoration Facility. The operators practiced using the arm and the end effectors during training.

Secondary Waste Considerations

Most of the secondary waste is wastewater from equipment decontamination. This wastewater drains into the tank and becomes tank waste.

Concerns/Risks

This system's remote operation reduces direct contact with the tank and its contents. The risk from the decontamination water is negligible, as are any other risks associated with this technology. Some tasks, such as end effector exchange, require operator activities above the tank, but do not pose significant risks to workers.

Figure 2. System operators trained using the LDUA in a cold-test facility prior to deploying it into underground storage tank

SECTION 3
PERFORMANCE

Demonstration Plan

The LDUA with the Stereo Viewing System was demonstrated at the Hanford Site in 1995–96 and deployed at INEEL in 1999. However, the Stereo Viewing Systems were not identical. Hanford upgraded its internal camera controls for aligning the video cameras to obtain the precision dual focusing needed for depth perception. At Hanford, close-up, high-resolution, stereo views of the tank interior and contents were obtained. INEEL did not make these modifications. At INEEL, high-resolution, nonstereo views were obtained. The single video mode provided sufficient resolution for details needed in the inspections.

Major Objectives

- At Hanford, the Stereo Viewing System was used to perform close-up inspection of the condition of the interior of a single shell tank for the first time. Extensive sections of the tank wall were examined to investigate tank integrity.

- At INEEL, the Stereo Viewing System was deployed in a non-stereo mode for a preliminary visual inspection inside the tank followed by deployment of an NDE end effector for weld defect and corrosion inspection and a sampling end effector to obtain heel samples.

Major Elements

Stereo Viewing System applications include performing high-resolution inspection to support tank integrity and investigations. The Stereo Viewing System is deployed using the LDUA, and the deployment is sometimes assisted by an overview video unit positioned in an adjacent riser to observe tank entry of the LDUA and for collision avoidance. The overview video unit remains in use until the arm is removed. The video signal is processed using a special computerized image processing system and downloaded to a special monitor display unit (custom designed 3-D viewing glasses).

Results

Hanford

In May 1995, a prototype of the Stereo Viewing System was demonstrated in Hanford Tank 241-TX-115. Standard tank operations inspection equipment was modified by adding two video cameras that were lowered through the tank riser to do a routine tank inspection. The cameras provided side-by-side images, which were optically blended to produce a three-dimensional effect when viewed through a pair of special glasses. The test familiarized tank farm operators with the capabilities of the actual Stereo Viewing System, which was delivered in June 1995.

The Stereo Viewing System went through a rigorous testing and qualification program at the Hanford LDUA test facility before receiving approval for use in a radioactive waste tank. The system was modified to allow depth perception and to reduce the weight by 18 pounds. On September 27, 1996, the LDUA system with the Stereo Viewing System end effector was deployed in the Hanford Tank 241-T-106. During this deployment, the Stereo Viewing System enabled examination of the tank dome, a riser, and welds in the tank wall from only a few inches away. The video images provided sharp, clear images. There was some oscillation when moving, but it did not cause any blurring. Pits of various sizes were observed in the tank liner and some welds.

INEEL

On February 12, 1999, the LDUA with the Stereo Viewing System end effector was deployed through a 12-inch riser into Tank WM-188 at INEEL, as depicted in Figure 3. Tank WM-188 is a 300,000-gal underground stainless steel tank approximately 50 ft in diameter and 45 ft from riser top to tank bottom. The tank contains a residual heel of high-level radioactive liquid waste about 10 inches deep. The deployment occurred under winter conditions with the outside air temperature down to 5°F, snow cover, sustained winds approaching 25 mph, and precipitation. Operations staff devised an enclosed tent to protect the riser area where the end effectors were exchanged and heel samples were packaged for transport to the laboratory.

During the deployment, the Stereo Viewing System was used in a non-stereo mode (as a single video camera to inspect the internal condition of Tank WM-188). The lighting system aided in the differentiation by providing the ability to shadow the viewing area by turning on and off pairs of fixed-intensity lights.

The Stereo Viewing System was the first end effector deployed into the tank, followed by an NDE end effector for weld defect and corrosion inspection. End effectors were exchanged using a remotely operated system. Following the inspections, a sampling end effector was used to obtain three heel samples from different locations on the tank floor. The heel samples confirmed historical data presently used to estimate chemical and corrosive characteristics of the tank heel and to support grout formulations for eventual closure of the tank. Use of the LDUA and end effectors will continue through 2012 at INEEL to sample and inspect other tanks.

Figure 3. The Light Duty Utility Arm deployed various end effectors into tank WM-188 at the INEEL tank farm to take interior video and collect waste samples.

SECTION 4
TECHNOLOGY APPLICABILITY AND ALTERNATIVES

Competing Technologies

The Stereo Viewing System is an innovative technology, which uses a pair of cameras to enable the perception of depth. The hardware was modified from state-of-the art technology for use with the LDUA in radioactive environments. This technology is also used in an Overview Stereo Video System that does not require the LDUA for deployment (see Figure 4).

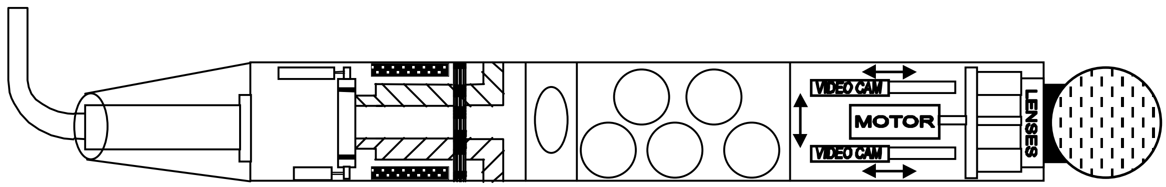

Figure 4. The Overview Stereo Video System is manually deployed through the tank riser.

Deploying the Overview Stereo Video System with less resolution than the Stereo Viewing System is an alternative to using the Stereo Viewing System. The Stereo Viewing System has distinct advantages over the alternative listed above. Deploying the Stereo Viewing System using the LDUA allows areas as small as 1.26 by 0.95 inches to be inspected from any location in the tank that can be accessed by the LDUA.

Technology Applicability

The Stereo Viewing System has the following applications:

- support tank integrity assessment, sampling of tank waste, and waste retrieval operations;
- document tank interior and waste characteristics for current and future analysis; and
- safety monitoring and troubleshooting.

In determining the applicability of the technology for other tanks, the following parameters should be considered:

- Access—risers must be able to accommodate the LDUA equipment's dimensions.
- In situ operations—obstructions within the tank may hinder the equipment's ability to access desired locations.
- Tank dome loading—equipment may need to be supported by a load-bearing platform.

Patents/Commercialization/Sponsor

Westinghouse Savannah River Company developed the Stereo Viewing System with funding from the DOE's Office of Science and Technology under the direction of the Tanks Focus Area. Deployment of the Stereo Viewing System was a joint effort by

- Pacific Northwest National Laboratory
- Idaho National Engineering and Environmental Laboratory
- Lockheed Martin Idaho Technologies Company
- Lockheed Martin Energy Systems
- Westinghouse Hanford Company
- Savannah River Technology Center
- Bristlecone Environmental Technologies
- Numatec Hanford Company

DOE OST, ER, and TFA sponsored development and deployment of the Stereo Viewing System. High-resolution remote video systems are available commercially, but radiation-hardened systems are not yet commercially available. SPAR Aerospace manufactured the LDUA, the robotic arm that moves the Stereo Viewing System around in the tanks.

SECTION 5
COST

Methodology

Costs for deploying the Stereo Viewing System in INEEL's Tank WM-188 are summarized below. The baseline technology was inspecting tanks by manually lowering a film or video camera to positions directly below the tank riser. The costs for deploying baseline technologies was likely to be significantly less than for deploying the Stereo Viewing System because of the training and deployment costs associated with the LDUA. When the cost of the overall project and the consequences of failure were considered, however, the Stereo Viewing System was determined to have positive cost impacts. The Stereo Viewing System was selected for deployment because

- it provided better visual information, enabling up-close, high-resolution inspections,
- the LDUA was already being deployed for NDE and tank sampling,
- the technology for remote end effector exchange was already available, and
- the technology provided access to areas in the tanks other than those just below a riser.

Cost Analysis

Table 1 reports the costs incurred for deployment of the Stereo Viewing System at INEEL.

Table 1. Costs of Stereo Viewing System development and deployment at INEEL Tank WM-188

Development and deployment breakdown		Cost ($K)
Capital cost	Stereo Viewing System development	100
Operating costs	Remote inspections to assess tank integrity[a]	250

[a]Includes funds to perform LDUA tasks required to deploy the Stereo Viewing System and other end effectors.

Capital and Operating Costs

The INEEL cost to develop the Stereo Viewing System was $100K. The cost to deploy the LDUA most recently at INEEL was $250K. This cost covers labor for the operating crews, project management, and consumable items. Future capital and operating costs will vary greatly depending on the deployment site and the equipment used to field the Stereo Viewing System (e.g., LDUA type, support equipment, specialty staff, etc.).

Cost Benefits

Data obtained in the non-stereo mode on tank structural condition may allow selection of less expensive tank retrieval and closure options. Cost benefits can also be realized through lower worker risk during sampling, reduced monitoring after closure, and eliminating the need for constructing additional tankage. Without this data, regulators may reject closure options, or unnecessary conservatism may be factored into closure options.

Table 2 summarizes estimated costs of the various closure options. The estimates address closing 11 tanks, tank vaults, and ancillary piping located in the Tank Farm Facility at the INTEC. In the past, the base requirement was clean closure (option 2 or 3), which is to remove all waste, leave the tank structures in place, and fill the tank voids. The current plan is to perform a risk-based clean closure, if possible, or landfill closure, as a contingency (option 2 or 4), which includes removing the waste and grouting the remaining heel in place. Clean grout will then be used to fill the rest of the tank above heel level and fill the surrounding vault. The cost differential between these options is over $50 million. The cost benefits are significantly greater when all cost benefits are considered.

Table 2. Estimated costs of INEEL high-level waste tank closure options

Option	Estimated cost ($ millions)
1. Tank Removal and Demolition Closure	5,330
2. Risk Based Clean Closure, LLW Grout Fill	205
3. Risk Based Clean Closure, CERCLA Waste Fill	238
4. RCRA Landfill Closure, LLW Grout Fill	185
5. RCRA Landfill Closure, CERCLA Waste Fill	220
6. Close to Landfill Standards, Clean Fill	135

Source: Spaulding, B. C., et al. 1998.

Technology Scale-Up

Scale-up is not an issue with the Stereo Viewing System; however, inspection of large tanks may require multiple deployments of the LDUA into different risers if its reach is from a single riser is not sufficient to inspect suspicious areas.

Cost Conclusions

Using the Stereo Viewing System results in costs savings from using collected data to implement less conservative retrieval and closure alternatives. The cost differential between options is as high as $100 million.

Using the Stereo Viewing System end effector results in cost savings from

- operating inspections remotely rather than imposing risk to workers to manually inspect the inside of the tank,
- using collected data to implement less conservative retrieval and closure alternatives,
- certifying existing tanks rather than constructing new ones,
- selecting better treatment options, and
- reducing monitoring requirements after closure.

SECTION 6
REGULATORY AND POLICY ISSUES

Regulatory Considerations

In general, radioactive waste in storage tanks at DOE sites is subject to a number of different regulations and regulatory authorities, including the following:

- DOE Order 435.1, Radioactive Waste Management requiring all DOE waste is managed in a manner that protects the worker, public, and the environment.
- Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA).
- Resource Conservation and Recovery Act of 1976, Public Law 94-580, as amended (RCRA).
- State of Idaho. Oct. 16, 1995. “Settlement Agreement,” U.S. District Court of Idaho, Civil No. 91-0054-S-EJL.
- Notice of NonCompliance Consent Order - State of Idaho. The Consent Order, developed by the state, requires DOE’s Idaho Operations Office to cease use of the five pillar and panel vault tanks by 2009 and to cease use of the remaining six tanks by 2015. An August 1998 modification tot he Consent Order accelerated these dates to 2003 and 2012, respectively.
- *INEEL Site Treatment Plan* describes how DOE-Idaho proposes to treat or develop treatment for mixed waste and the schedules to accomplish these tasks

Waste storage and treatment facilities are also required to meet Clean Air Act and Clean Water Act requirements for liquid and airborne effluents. Requirements are typically implemented at the state or even the local levels for these statutes.

Secondary Waste
Most of the secondary waste, which is governed by EPA, is wastewater derived from decontamination of the equipment. DOE is responsible for safe waste storage and treatment of the waste.

CERCLA Evaluation
This section summarizes how the Stereo Viewing System addresses the nine CERCLA evaluation criteria.

1. Overall Protection of Human Health and the Environment

    - Inspecting and monitoring tanks with hazardous or radioactive components with remote-controlled operations significantly minimizes exposure to workers.
    - Tanks can be isolated faster, with fewer personnel, in much safer surroundings, thus reducing threats to human health and the environment.
    - More effective treatment options can be selected.

2. Compliance with Applicable or Relevant and Appropriate Requirements (ARARs)

    - The Stereo Viewing System was designed and deployed according to applicable regulatory requirements.
    - Established procedures and controls are in place to ensure compliance.

3. Long-term Effectiveness and Permanence

   - This technology can help accelerate tank remediation and closure schedules.

   - This technology can help accelerate waste treatment schedules.

   - The Stereo Viewing System is radiation hardened and was constructed to withstand temperatures 0–50^{o}C.

4. Reduction of Toxicity, Mobility, or Volume through Treatment

   - This system replaces manual deployment of devices to inspect tank integrity, which generates significant amounts of secondary waste due to exposure of additional tools and clothing to radiation sources.

5. Short-Term Effectiveness

   Radiation exposure to workers is maintained as low as reasonably achievable (ALARA) through the following measures:

   - The inspection and data collection is done remotely.

   - Established procedures and controls exist, and workers are thoroughly trained and qualified.

6. Implementability

   - Deploying tools while the LDUA is in a tank for needed retrieval or closure activities optimizes efficiency and cost.

   - Worker exposure is minimized.

   - Worker training and qualification programs and procedures are in place.

7. Costs are provided in Section 5.

8. State (Support Agency) Acceptance

   - EPA and the states of Idaho, Washington, and Tennessee are parties in agreements that cover regulatory issues and establish requirements for management of tanks and tank waste.

9. Community Acceptance is discussed below.

Safety, Risks, Benefits, and Community Reaction

Because the main components of the Stereo Video System are operated remotely, no major worker safety issues are posed by using this equipment. The support equipment includes a decontamination system as part of the LDUA. This feature enables remote decontamination of the LDUA and the Stereo Video System. The other support systems are located above the tank and require hands-on operation; however, the support equipment does not present any special safety concerns for workers.

Public and stakeholder reaction to the successful deployment of the LDUA and Stereo Video System at the WM-188 tank at INTEC was positive. The technology is viewed as low risk and essential in obtaining data to appropriately close underground tanks, as stipulated in the Idaho Settlement Agreement, as well as, to evaluate various waste treatment options.

SECTION 7
LESSONS LEARNED

Implementation Considerations

The technology performed well in the field during the Stereo Viewing System demonstration at Hanford. Several issues were resolved for INEEL deployment including the following:

- Improvements to the graphic user interfaces and the ergonomics of some of the components were suggested.

- Due to operational issues, three of the four sets of lenses were removed. The cameras were repositioned with one set of lenses to give an 18 inch stand-off stereo focal point. This view was not considered superior to using one camera in non-stereo mode, so the second camera was not used for the inspection.

Technology Limitations and Needs for Future Development

Deployment of Stereo Viewing System at INEEL revealed insights that can be applied to future applications:

- Layout drawings of DOE underground storage tanks are not always accurate. In the past, when new piping or changes were made to a tank, documentation was not always updated to reflect the changes. Process knowledge can be used to help determine current in-tank configurations.

- With end effectors such as the Stereo Video System, the LDUA has performed very reliably after thousands of hours of operations. Only minor problems have been encountered when compared to other in-tank systems.

Technology Selection Considerations

The Stereo Viewing System provides a three-dimensional imaging capability for inspecting suspect features on tank structures or in tank waste. A special lens provides a zoom capability while maintaining scaling capability to accurately size anomalies. The lens system uses a pair of color video cameras that provide a stereoscopic image to aid in the differentiation between pits and bumps. The camera system also gives volumetric data that can assist in planning and executing waste characterization and retrieval operations.

APPENDIX A
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APPENDIX B
ACRONYMS AND ABBREVIATIONS

ALARA	as low as reasonably achievable
ARARs	applicable or relevant and appropriate requirements
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
DOE	U.S. Department of Energy
EPA	Environmental Protection Agency
ER	U.S. Department of Energy Office of Environmental Restoration
FY	fiscal year
INEEL	Idaho National Environmental and Engineering Laboratory
INTEC	Idaho Nuclear Technology Engineering Center
LDUA	Light Duty Utility Arm
NDE	nondestructive examination
NHC	Numatec Hanford Company
OST	Office of Science and Technology
PNNL	Pacific Northwest National Laboratory
RCRA	Resource Conservation and Recovery Act
TFA	Tanks Focus Area
TMS	Technology Management System